

A NEW AUSTRALIAN "*DINETA*/*BARBRONIA*-LIKE" LEECH, AND RELATED MATTERS. (HIRUDINOIDEA: ? ERPOBDELLIDAE)\*

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[Accepted for publication 17th June 1970]

*Synopsis*

The first detailed account is given of the morphology of an Australian erpobdelliform leech which shows novelty in the mouthparts, reproductive system, in the possession of postcaeca, and is most doubtfully a member of the currently cosmopolitan Family Erpobdellidae. It differs in somital annulation from the inadequately described *Dineta cylindrica* Goddard 1909 of N.S.W. A resemblance to leeches in the genus *Barbronia* is shown as superficial by reanalysis of the morphology of *B. rouxi* Johansson 1918, the type for the genus, and this excludes the common Oriental leech *B. weberi* (Blanchard 1897) from *Barbronia*. New genera are provided for *weberi* and for the new Australian species.

Medium-sized leeches from Sullivans Creek, in the ground of the Australian National University, Canberra, are arhynchobdellid; macrophagous; erpobdellid in facies; resemble leeches in the genus *Barbronia* in the ocular pattern and in the location of the eyes and median copulatory pores, differ in the undivided condition of elongate annuli in complete somites and in the morphology of the median reproductive regions, as also the absence of stylets; resemble the inadequately known Australian *Dineta cylindrica* Goddard, 1909, in the annulation of the complete somite and absence of stylets, differ in ocular pattern, in somital annulation, etc. They possess unusual structures at the mouth of the pharynx; and in the presence of small postcaeca in xix, differ from the characteristic acaecate condition in the F. Erpobdellidae as now recognized. For the time being, the new genus provided for them is placed with considerable reservations provisionally in the F. Erpobdellidae.

In erpobdellids, there are often fleshy papillae anterior to the entrance to the pharynx. These are termed paragnaths and regarded as vestiges of the "buccal velum", fleshy folds forming open grooves housing the jaws in the contracted sucker of the aquatic hirudiniform sanguivore. In the sanguivore, the sucker is formed from somites i to vi; the entrance to the pharynx, at vi/vii; the jaws in vi; the "buccal velum" in iv and v. In the agnathous macrophagous erpobdellids, somites i to iv form the sucker; the entrance to the pharynx at iv/v; paired papillae pendent from the inner surface of the sucker, often recognized as paragnaths, are in iii, and being anterior to the morphological position of the "buccal velum" cannot have identity with this, nor can the ventromedial structure in iv in other erpobdellids, since iv is not represented in the lateral and ventral portions of the sucker in the sanguivore where these are formed by v. The earlier descriptive practice conceals the distinctive morphology of the sucker and related structures in the erpobdellid, and will not be followed here.

The entrance to the pharynx is at iv/v in the Canberra leech, closed above by right and left flaps subrectangular in form with the base at iv/v, extending posteriorly to end as papillae free in the lumen of the pharynx; and below by distinct subvertical right and left elongate ventrolateral muscular ridges at the anterior end of internal muscular ridges in the pharynx. The ventrolateral

\* Prepared during the course of studies on Australian leeches assisted by a grant from the Nuffield Foundation.

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ridges may well have some prehensile function, which does not seem possible for the soft fleshy dorsal structures which have more of the nature of valves, and may be sensory. It is suitable to refer to these structures as: ventrolateral myognaths; and dorsal valves.

The median regions of the reproductive systems in the Canberra leech are amyomeric, micromorphic, the atria of the size of a nerve cord ganglion, and very thin-walled; and so quite unlike the deeply cleft large muscular male atrium with cornua in *Erpobdella*, *Trocheta*, *Dina*, *Nephelopsis* (v. Moore, 1901, 1912; Mann, 1952; Pawlowski, 1948), and some other genera which on this basis indicate a potential F. Erpobdellidae in contrast to the heterogeneous Erpobdellidae s.l. (v. Soos, 1966) based largely on a generalized erpobdellid facies, and the general nature of the pharynx and related structures.

Moore (1927) refers to the crop in the Erpobdellidae as characteristically acaeate, but notes that rarely there may be a pair of very small postcaeca or even a single postcaecum in xix. I have been unable to find such caeca reported in the members of the F. Erpobdellidae as now recognized (Soos, 1966). It seems most probable that Moore had in mind one or other of the leeches now transferred out of this family. Something in the nature of a postcaecum was figured for a leech in the erpobdellid-like South American g. *Cylicobdella*; but the genus as now known is acaeate. Reduced postcaeca such as in the Canberra leech are known in agnathous macrophagous haemopids (*Bdellarogatis plumbeus*, North America), a group which has had a diverse systematic history with some species confused by some authors as having erpobdellid affinities. I cannot take the matter further. At present the F. Erpobdellidae is acaeate.

In assembling the few records of erpobdellid-like leeches in Australia (Richardson, 1968), I notified the presence of several species which are barbronia-like in having some features known in the g. *Barbronia* based on *B. rouxi* Johansson, 1918 of New Caledonia: a genus now containing (Soos, 1966): *B. weberi* (Blanchard, 1897) of the East Indies, India, Afghanistan, with a subsp. *formosana* in China, Korea, Hawaii, etc.; and *B. delicata* Moore, 1939 of the Belgian Congo and Lake Tanganyika, which Moore placed provisionally in this genus.

The only described named erpobdellid in the Australian Region other than *B. rouxi*, is *Dineta cylindrica* Goddard, 1909 based on a single specimen 25.0 mm. long from near Oberon, N.S.W. Goddard's account lacks many details.

It is necessary to assess closely *Dineta* and *Barbronia* in order to determine the generic status of the Canberra leech. In doing this, it becomes clear that *weberi* cannot be retained in *Barbronia*, and a new genus is provided for this common Oriental leech. "*B.*" *delicata* is equally not a member of *Barbronia*; but this cannot be carried further at this time.

*Barbronia rouxi* Johansson, 1918.

Johansson's descriptions of leeches are commonly based on 25 preanal somites (Richardson, 1969) and require careful interpretation. The account of *B. rouxi* is based on a prostomium + 24 preanal somites, i to xxiv, the anus at xxiv/xxv, and 5 postanal annuli attributed to xxv to xxvii. He recognizes (v or) vi to xxii as 5-annulate (v having  $b_1/b_2$  weak on the venter), a total of (17) 16 complete somites, each with  $b_6$  as the longest annulus and in most divided as ( $c_{11} + c_{12}$ ). With this, he locates the eyes in i and iii; the genital pores in  $b_1$  in x and xi; the clitellum, viii  $b_5$  to xi  $a_2$  inclusive; the pharynx terminating at xi/xii; testes, 11 or 12 on each side, in xii to xiv (or xv); etc.

Johansson's somital annulation for *rouxi* gives a total of 104 annuli between the anus and the prostomium. It would seem that taking the prostomium as somite i, which would place the eyes in ii and iv, establish iv as 3-annulate with  $a_1a_2$  forming the ventral rim of the sucker, the genital pores at xi  $b_1$  and xii  $b_1$ , etc., would bring Johansson's account into line with the correct somital morphology; but this places the clitellum from ix  $b_5$  to xii  $a_2$  and is not an acceptable interpretation. It indicates that here, as has been found elsewhere (Richardson, 1969) Johansson's method conceals the presence of one somite between the sucker and the genital region.

Re-analysis on the basis of 105 preanal annuli, the location of the eyes, of the elongate  $b_6$ , the clitellum, etc., gives the following somital morphology: i and ii, uniaannulate with the first pair of eyes in ii; iii, 2-annulate; iv, 3-annulate above with the 2nd eyes in  $a_2$ ,  $a_1a_2$  below forming the margin of the sucker; v, 2-annulate; vi, and vii 3-annulate; viii, 4-annulate,  $b_6$  elongate; ix to xxiv, 5-annulate (total 16),  $b_6$  ( $c_{11} + c_{12}$ ) the longest in each; xxv, 3-annulate; xxvi, 2-annulate; anus at xxvi/xxvii; xxvii, 2-annulate or 3-annulate, followed by 2 or 3 accessory annuli, i.e., 4 or 5 postanal annuli in all; clitellum, x  $b_5$  to xiii  $a_2$  inclusive; genital pores, xii  $b_1$  and xiii  $b_1$ ; the pharynx ending at xiii/xiv; testes in xiv to xvi. There is agreement here with general morphological principles, and the somital morphology of *rouxi* can be directly compared with that of *weberi*, the Canberra leech, etc. The g. *Barbronia* as described from the type species, follows:

g. *Barbronia* Johansson 1918.

Erpobdelliform; ix to xxiv 5-annulate (total 16),  $b_6$  ( $c_{11} + c_{12}$ ) the longest annulus; i and ii, uniaannulate a pair of dorsal eyes in ii; iii, 2-annulate; iv, 3-annulate above, 2 pairs of eyes lateral in  $a_2$ ,  $a_1a_2$  forming the lateral and ventral margin of the sucker; v and vi, 3-annulate; vii, (incompletely 4- or) 3-annulate; viii, 4-annulate; xxv, 3-annulate; xxvi, 2-annulate; anus, xxvi/xxvii; xxvii, 2- (or 3-) annulate + accessory annuli = 4 or 5 postanal annuli; dorsomedian and ventrolateral "jaws", each with 2 stylets; pharynx, strepsilaematous, terminating at xiii/xiv (? at xii/xiii + elongate sphincter); crop, acaecate, terminating in xix; nephridia, 14 pairs; nephropores, obscure; genital pores, xii  $b_1$  and xiii  $b_1$ ; copulatory pores, x/xi and xiii/xiv; testes, large, saccular, 11 or 12, as an interrupted row on each side from g. xiv to xvi/xvii; vasa deferentia commence behind xvi; ejaculatory bulbs anterior in xiv extend to xii  $b_1$ , uniting to form a common median duct leading to a small simple bursa; ovaries, tubular, short, extending from g. xiv and reducing to oviducts at about xiii/xiv which enter a short narrow "vagina". Size, medium. Colour, preserved grey. No pattern. Freshwater. Macrophagous. Australian Region.

*Type species: Barbronia rouxi* Johansson, 1918. New Caledonia.

The above is derived from Johansson (1918).

*Barbronia weberi* (Blanchard, 1897).

Moore (1927, 1939) followed his usual conservative practice in placing *weberi* and *delicata* in the g. *Barbronia*, both being erpobdellid in facies, in the ocular pattern, in somital annulation with complete somites 5-annulate and  $b_6$  the longest annulus, in the nature of the pharynx and related structures, etc.; and barbroniid-like in the subdivision of  $b_6$ , the possession of stylets, a short testicular region, etc.; *weberi*, like *rouxi* in the number and location of the eyes, the number and position of the copulatory pores, differing in having  $a_2$  divided, and in the nature of the male median region; *delicata*,

resembling *rouxi* in the nature of the male median region and  $a_2$  simple; differing in the anterior eyes widely spaced, in lacking copulatory pores, and the testicular region posterior, in xvii to xix, etc.

Here, as elsewhere, Moore placed in the one genus species exhibiting diversity in somital annulation, the morphology of the reproductive systems, etc. (Richardson, 1969) and so failed to achieve a synthesized concept of genus, as can be seen by comparing the generic description for *Barbronia* above with that of the new genus provided below for *weberi*. It is not possible here to go further in the matter of *delicata* which Moore fully anticipated would not remain in *Barbronia* or continue associated with *weberi*.

*Sciobdella* gen. nov.

*Derivation*: *scio*, to know; *bdella*, a leech. f.

Erpobdelliform; viii to xxiv 5-annulate (total 17),  $a_2(b_3 + b_4)$  and  $b_6(c_{11} + c_{12})$  elongate,  $b_6$  the longer; i and ii, uniannulate, with a pair of dorsal eyes in ii; iii, 2-annulate; iv, 3-annulate above with 2 pairs of eyes lateral on  $a_1/a_2$ , and  $a_1a_2$  forming the lateral and ventral margin of the sucker; v, 2-annulate; vi, 3-annulate; vii, (incomplete 5- or) 4-annulate; xxv, 3-annulate; xxvi, 2-annulate; anus, xxvi/xxvii; xxvii, 2-annulate; somital sense organs, minute, obscure; dorsomedian and ventrolateral "jaws" each with (1 or) 2 stylets; pharynx, strepsilaematous, terminates?; nephridia, ?; nephropores, detectable; genital pores, xii  $b_1/b_2$  and xiii  $b_1$ ; copulatory pores, x/xi and xiii/xiv; testes, large, simple saccular, 5 to 8 on each side in xiv and xv (some with 1 in xvi); vasa deferentia lack a preatrial loop, terminate with enlarged "sperm vesicles" joined independently each to a short curved dorsolateral cornu on the compact, thick-walled, short spheroidal atrium; ovaries each with a short caudolateral lobe, and a short globoid body reducing to short oviducts joining to open at the genital pore.

Size, medium. Colour, ? reddish in life. Pattern, preserved, faint lines or reticulations. Freshwater. Macrophagous. Oriental Region.

*Type species*: *Dina weberi* Blanchard, 1897. Locality, ?.

The above data are taken from Moore (1927) with corrections (1946).

*Dineta cylindrica* Goddard, 1909.

There is no indication of the existence of the type specimen, and the leech known only in Goddard's incomplete account. Goddard recognized the leech as erpobdellid, which Soos (1966) maintains. The full somital annulation cannot be directly determined, but fortunately Goddard gives the total number of annuli, the number of postanal annuli, location of the genital pores by the number of dorsal and ventral annuli, and figures the position of these in relation to the elongate annuli. He locates 3 sets of eyes, the last in annulus 6 which (his fig. 7) forms the lower margin of the sucker and accordingly is  $iv a_2$ ; his fig. 8 shows the annulation of somites "x" and "xi" as  $b_1 = b_2 = b_5 < a_2 < b_6$  with the genital pores in 37 and 42, quite definitely  $b_2$  in each: the anus between the 4th and 5th last annuli; total annuli, 105. This data permits reasonably reliable reconstruction of the morphology on the basis of the general principles of somital annulation, as follows:

Somites ix to xxiv, 5-annulate (total 16),  $b_6$  elongate and not subdivided; i, uniannulate, weakly and incompletely marked off from ii, 2-annulate with eyes in  $a_1a_2$ ; iii, 2-annulate, eyes in  $a_1a_2$  (= his annulus 3); iv, 3-annulate above, eyes in  $a_2$  (= 6), 2-annulate below,  $a_1a_2$  forming the lateral and ventral margin

of the sucker; v, 2-annulate ( $a_1a_2$  possibly weakly furrowed); vi, 3-annulate; vii, 3-annulate; viii, 4-annulate, with  $b_6$  elongate; xxv, incomplete 4-annulate,  $a_3(b_5 + b_6)$ ; xxvi, 2-annulate; anus, xxvi/xxvii; xxvii, 3-annulate + 1 accessory annulus, total 4 postanal annuli; pharynx, strepsilaematous, terminating xii/xiii; (Goddard' puzzling reference to a "proboscis-like organ" at this level is to the elongate sphincter); crop, acaecate; genital pores, xii  $b_2$  and xiii  $b_2$ ; 7 saccular testes.

Nothing further can be drawn with confidence from Goddard's account until specimens can be studied. He does not refer to jaws, stylets, copulatory pores, etc., to details of the male paired ducts or the median reproductive structures, although from his description of the sphincter, he had studied sections in this region, indicating possibly the absence of muscular organs.

The conclusions which can be reached are:

*Dineta cylindrica* is erpobdelliform; barbronia-like in external topography and in the relative lengths of annuli in the complete somite; resembles *rouxi* in the number of complete somites, *rouxi weberi* and the Canberra leech in the position of the genital pores; differs from *rouxi* and *weberi*, and resembles the Canberra leech in having  $b_6$  undivided, but has 16 and not the 17 complete somites as in the Canberra leech. Two other "barbronia-like" Australian leeches known to me have a highly complex annulation; another two with a simple annulation have a nearly transparent bodywall, one has stylets; these, *rouxi* and the Canberra leech have a common ocular pattern, not eyes in ii, iii and iv, as in *cylindrica*. Variation in the number and location of eyes in erpobdellid leeches is well known (v. Mann, 1952, *Dina lineata*), with an eye reduced in size or lacking, accessory eyes present in ocular or adjacent annuli, but this is without significant variation in the annulation of the ocular region. The 2-annulate condition of ii is seen only in *cylindrica*.

*Dineta cylindrica* should be fully recognizable again in other specimens. The indications are that it stands apart generically from the Canberra leech.

*Vivabdella* gen. nov.

Derivation: viva, living; bdella, a leech. f.

Erpobdelliform; viii to xxiv, 5-annulate (total 17),  $b_6$  commonly the longest annulus and not further subdivided; i, uniannulate; the furrow i/ii, incomplete laterally; ii, uniannulate with a pair of dorsal eyes; iii, incompletely 2-annulate; iv, 3-annulate above, a pair of eyes dorso-lateral on each side on  $a_2/a_3$ ,  $a_1a_2$  forming the lateral and ventral margin of the sucker; v, 3-annulate; vi, 3-annulate; vii, 4-annulate; xxv, 3-annulate, xxvi, 2-annulate; anus, xxvi/xxvii; xxvii, 2- or 3-annulate; entrance to pharynx closed by a pair of posteriorly directed dorsal valves, and ventrolateral myognaths; no stylets; pharynx, strepsilaematous, terminating at xii/xiii; crop acaecate excepting for reduced postcaeca from the middle of xix reaching to xix/xx; nephridia, ?; nephropores, very minute, obscure; genital pores, xii  $b_1$  (posterior in xi  $b_6$ , xi/xii) and xiii  $b_1$ ; copulatory pores, median, x/xi and xiii/xiv; median regions of reproductive systems, amyomeric, micromorphic; testes, large, simple saccular, 7 or 8 in each of two irregular rows in xiii to xvi; vasa deferentia, simple, enter directly and independently into the thin-walled minute atrium; no sperm ducts, vesicles, ejaculatory bulbs, preatrial loops, or atrial cornua; ovaries, short, tubular, joining to form a simple thin-walled minute atrium; no oviducts or vagina.

Size, medium. Colour, in life, reddish. Pattern, none. Freshwater. Australian Region.

Type species: *Vivabdella arcana* sp. nov. as follows:

VIVABDELLA ARCANA SP. NOV. FIG. 1, A. TO G.

Holotype: Australian Museum, Sydney. Coll. No. W.4266. One specimen, preserved, 20.0 mm. long.

Paratypes: A.M. Coll. No. 4267. Two specimens, 14.0 mm. and 24.0 mm. long. Collected April 6 and May 1 1970, from beneath stones on a mud bottom,

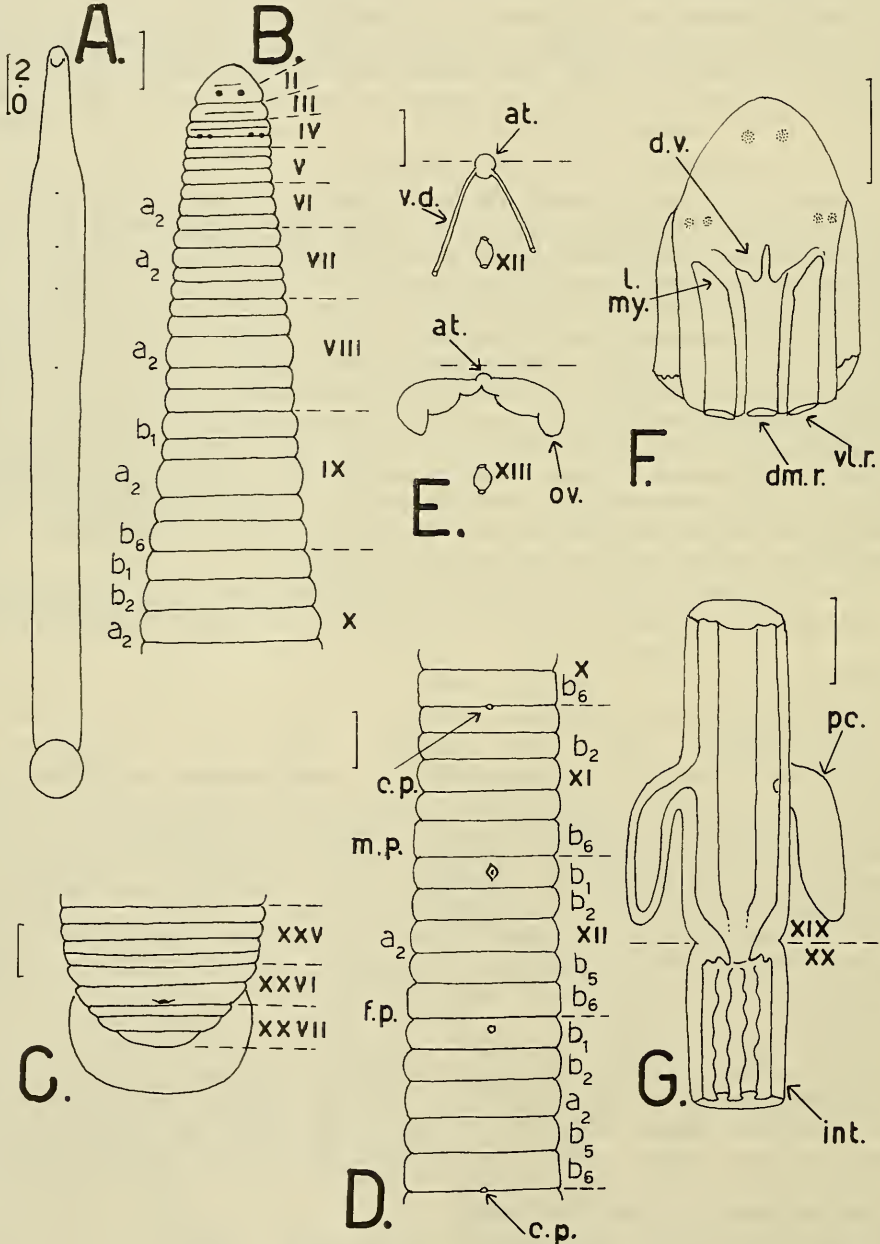


Fig. 1. See legend on page 227.

above the weir on the lower end of Sullivans Creek in the grounds of the Australian National University Canberra, A.C.T. Collectors, Dr. M. J. Howell, Dr. R. E. Barwick, the Australian National University.

Conservative dissection cannot be carried out on this leech. Irregularities in extension affect the relative lengths of annuli. For these reasons, the following description is based on the series. Of these, two were killed in the old manner, with hot water. No secondary subdivision of elongate annuli appeared.

#### GENERAL FORM

In life, opaque; at rest: depressed, very low convex above, the margins narrowly rounded, widest over the middle third of the body, tapering very gradually to the velum which may be obtusely rounded or, with the first few somites extended, narrowly and acutely elongate; abruptly rounded posteriorly to form the basis for the posterior sucker which is narrower than the maximum width of the body.

Firmly muscular to the touch. Very highly extensible. A specimen at rest, 16.0 mm. long with a maximum width of 2.5 mm.; fully contracted, 12.0 mm. by 3.5 mm.; in full extension, 33.0 mm. by 2.0 mm.

Fully extended, the form is elongate cylindroid, with the width a little more than the depth along the greater length of the body; the width reducing abruptly near the base of the circular sucker which is wider than the body; tapering very gradually along the preclitellar region to end obtusely with the velum.

The clitellum is not clearly marked off in contraction, and only slightly shouldered in the extended specimen.

Relaxed and preserved, the form is generally that of the extended animal. A specimen 28.0 mm. in total length, was 0.8 mm. wide at iii/iv; 0.8 wide and deep at v/vi, and of this depth back to the clitellum, 4.4 mm. from the tip where the width is 1.6 mm.; the anterior copulatory pore at 5.5 mm., genital pores at 7.5 and 9.0 mm., posterior pore at 12.0 mm., the postclitellar region 1.8 mm. wide; diameter of the posterior sucker, 1.9 mm.

A very lively leech. When disturbed moves over the surface rapidly with full extension and strong contraction; extended when swimming, moving rapidly with the extended graceful undulation of leeches such as the North American "*Erypobdella*" *punctata* and *Dina M. fervida*.

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Fig. 1. *Vivabdella arcana* gen. nov, sp. nov. A. Ventral view of an extended preserved specimen 28.0 mm. long. B. Annulation, dorsal aspect, somites i to x. C. Annulation, dorsal aspect, somites xxv to xxvii. D. Annulation, ventral aspect, somites xi to xiii, showing location of genital and copulatory pores. E. Anterior region of paired male ducts, atrium; and female reproductive system. F. Dissection from the ventral aspect of the entrance to the pharynx to show dorsal valves, ventrolateral myognaths, internal ridges of the anterior end of the pharynx; eyes, marked by stipple. G. Dissection of crop in xix showing reduced postcaeca, dorsal grooving, sphincter, and internal rugae in intestine.

Somites and somital ganglia indicated by Roman figures; intersomital levels, broken lines; annuli, "a<sub>2</sub>", etc.

at., atrium; c.p., copulatory pore; d.v., dorsal valve; dm.r. dorsomedian muscular ridge; f.p., female pore; int., intestine; l.my., lateral myognath; m.p., male pore; ov., ovary; pc., postcaecum v.d., vas deferens v.l.r., ventrolateral muscular ridge.

Scales in mm., 0.5 mm. unless otherwise indicated.

## COLOUR AND PATTERN

The colour in life, light brownish to reddish brown, paler below; under the microscope, yellowish to golden brown; preserved, the brown diminishes to very pale brown, and even to grey.

## BODYWALL AND MUSCULATURE

The bodywall is everywhere opaque, the only indication of internal organs are 2 or 3 large white patches which are testes, but not all the testes show. Preserved, the longitudinal musculature is readily seen, but not the oblique layers which are so delicate as to be detected only with difficulty in dissection. The opacity of the bodywall is due to the thick layer of tissue between the bodywall and the pharynx anteriorly, and the layer of large botryoidal structures along the length of the post clitellar region. In macrophagous haemopids, the pharynx and crop separate readily from the bodywall in dissection. In this leech, both are intimately associated with it and can be separated from it only with the greatest difficulty. The intestine and rectum are free in the median chamber.

In correlation with this, the dorsoventral palisades are much reduced; the paramedian strongly developed as a short length in xv, and along both sides of the intestine, elsewhere, a few isolated strands; the intermediates, sparse, spaced, and not recognizable as a palisade. I have not seen in any of the macrophagous haemopids I have dissected an equivalent to the short length of strongly developed paramedian palisade on each side of the crop in xv.

## NERVOUS SYSTEM

Because of the intimate relationship of the bodywall, crop and pharynx, this system could not be closely examined by dissection other than between ganglion xix and the caudal ganglionic mass, where there were only 6 and not the usual 8 independent ganglia. The 6 are equivalent in size, the last two closer spaced.

## ANNULATION. FIG. 1, B, C, D

Somital sense organs, minute, obscure, nowhere recognizable as longitudinal or transverse series; sensillae, not detectable; in life, showing relatively large low papillae in an irregular transverse row on the dorsum of all annuli in the last five or so somites, none on the venter, without somital significance, and not detectable in relaxed preserved specimens. Nephropores, not detectable regularly with any confidence. Intersomital and interannular furrows equivalent and somital limits recognizable only from the pattern of  $a_2$  and  $b_6$  longer than contiguous annuli, and  $b_6$  the longest annulus in many somites. Ventral nerve cord ganglia, slightly anterior in  $a_2$ , almost at  $b_2/a_2$  in 5-annulate somites. The following somital annulation is based almost entirely on these indications.

The anteriorly rounded triangular velum proper formed of i to iii, the 1st furrow, i/ii does not reach the margins and separates i incompletely from ii, uniannulate with a large dorsal eye on each side of the midline; ii/iii incises the margin; iii, incompletely 2-annulate,  $a_1a_2 > a_3$ ,  $a_1a_2/a_3$  not reaching the margins; iii/iv incises the margin, dividing the velum proper from iv, incompletely 3-annulate above,  $a_1 < a_2 < a_3$ ,  $a_1/a_2$  just reaching to the marginal field, 2-annulate below with  $a_1a_2$  forming the dorsolateral, lateral and ventral margin of the sucker, a pair of closely spaced small dorsolateral eyes on each side centred on  $a_2/a_3$ ; v, 3-annulate,  $a_1 < a_2 < a_3$ ; vi, 3-annulate,  $a_1 < a_2 > a_3$ ; vii, 4-annulate,  $a_1 = a_2 > b_5 < b_6$ ; viii, 5-annulate,  $b_1 = b_2 < a_2 > b_5$



$< b_6$  (i.e.,  $b_1 = b_2 = b_5 < a_2 < b_6$ ) which is generally the somital annulation back to xvi with  $b_1$  sometimes appearing slightly less than  $b_2$  but there is nothing constant in this; xvii to xxii,  $b_1 > b_2 < a_2 > b_5 < b_6$ ; xxiii and xxiv,  $b_1 > b_2 < a_2 > b_5 = b_6$ ; viii to xxiv, 5-annulate (total 17), and nowhere is there indication of furrowing subdividing  $b_6$  or  $a_2$ ; xxv, 3- (incompletely 4-) annulate,  $a_1 < a_2 < a_3$  or with a furrow  $b_5/b_6$  above and  $a_3$  ( $b_5 = b_6$ ), and  $a_3$  the last annulus across the venter; xxvi, 2-annulate,  $a_1 a_2 < a_3$ ; the anus at xxvi/xxvii or just posterior in xxvi  $a_3$ ; xxvii, 2- (or "3"-) annulate,  $a_1 a_2 > a_3$  (or (" $a_1 < a_2 > a_3$ ", and " $a_3$ " so little developed as to indicate it is an accessory annulus). Only irregular indications of concentric furrowing on the dorsum of the sucker.

Median copulatory pore at x/xi and xiii/xiv; genital pores at xii  $b_1$  (posterior in xi  $b_6$ , xi/xii), and xiii  $b_1$ .

#### ALIMENTARY TRACT, FIG. 1, F, G

The short cavity of the anterior sucker ends at iv/v; the entrance to the pharynx is large, unrestricted, macrophagous; contracted, Y-shaped, with right and left flat wide low fleshy pad-like valves, separated by a distinct formed median groove, occupying the space between the upper limbs of the Y, the two pads continuing briefly into the pharynx as posteriorly directed tapering lobes, bluntly angled distally and terminating free from the surface of the pharynx; on each side, lateral to the limbs of the Y, a low flat muscular ridge or myognath; no indications of stylets, no pockets; the dorsomedian groove does not continue on to the inner surface of the pharynx; a groove commences at the end of each limb of the Y, and the three extend the full length of the pharynx, dividing the inner surface of the pharynx anterior to the anterior ganglionic mass into a flat wide dorsal muscular band and right and left muscular bands, but behind the ganglionic mass the lumen of the pharynx has the form of an inverted Y with a pair of lateral bands and a ventral band continuing as such to the posterior end of the pharynx; the lumen, elongate saccular along the length, i.e., the pharynx, strepsilaematous.

The pharynx terminates at xii/xiii with a short sphincter, about half the length of xiii, narrower and less muscular than the pharynx, the wall thicker, and lined internally with longitudinal rugae.

The crop, elongate tubular; the wall thin, translucent; smooth internally excepting for shallow longitudinal grooves dividing it into dorsal, ventral, and lateral bands, but this seems to be only an expression of the attachment to the bodywall; lacking any indication of compartmentation, sphincters, and acaecate excepting in xix which has a pair of small caeca commencing at the median position in xix and continuing only to xix/xx. The crop terminates with a short sphincter at xix/xx opening terminally into the simple tapering tubular intestine lined with vermiform longitudinal rugae, joining terminally to the rectum in xxiv.

#### REPRODUCTIVE SYSTEM, FIG. 1, E

Median regions amyomeric, micromorphic.

Female mature, some with the clitellum well formed; developing male maturity.

Testes located in xvi, xiv, and xiii, saccular, ovoidal to subovoidal, 0.5 by 0.3 mm. to 1.25 by 1.1 mm.; arranged as irregular right and left series, some crowded beneath and others lateral to the crop, as a posterior cluster essentially in xvi with 4 on the left and 3 on the right, another in xiv, 1 on the

left and 2 on the right, and in xiii, 2 on the left and 1 on the right, a total of 7 on the left and 8 on the right; vasa efferentia, not detectable, nor the vasa deferentia until close to the atrium in the anterior half of xii where they could be recognized by the investing capillary bed as very narrow right and left thin-walled, transparent, non-muscular ducts resting on and narrower than the strands in the longitudinal layer of the muscular envelope, no more than 0.05 mm. in diameter, without indications of convolution as an epididymis or sperm duct or dilatation as a sperm vesicle or ejaculatory bulb, converging as simple straight ducts each to enter independently a posterolateral aspect of the atrium; the atrium, minute, about 0.2 mm. in diameter, thin-walled, non-muscular, almost transparent, embedded in the bodywall with the dorsal aspect raised just above the surface of the longitudinal muscular layer, so that the whole is entirely ventral to the nerve cord. The advanced condition of the testes contraindicates any systematically significant morphological change during functional development.

The thin-walled small, short stoutly tubular simple ovaries are each about 0.75 mm. long by 0.3 mm. wide, contained in the anterior two annuli of xiii, each with a short terminal lobe partly erect alongside the crop, and the rest ventral to the crop, transverse, reducing only briefly before both join to form the thin-walled atrium similar in size and relationships to the male atrium. There is no indication of distinct oviducts, a median vagina, or other functional chamber.

#### ACKNOWLEDGEMENTS

It is proper here to pay testimony to Dr. A. Soos for his key to and catalogue of genera in the F. Erpobdellidae. This has rapidly guided me through many difficulties in the course of this study, and I doubt it could have been completed under present circumstances without this aid; I also wish to acknowledge that, without the reliable detailed morphological accounts of erpobdellids by the late Professor J. Percy Moore, description of not only the erpobdellids discussed in this paper but also others which provide the picture of the comparative morphology of the leeches in this group, would have been difficult.

I am most grateful to Dr. M. J. Howell and Dr. R. E. Barwick, of the Australian National University who supplied me with the leeches from Canberra; to Miss E. Pope, Australian Museum, Sydney, who has been helpful in many ways; to Professor Marvin C. Meyer, the University of Maine, for assistance with difficult literature; and to the Librarian, the University of New England, Armidale, for help with other literature. The Science and Industry Endowment Fund has aided with the loan of microscopic and other equipment.

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